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(71) Applicant
Artus Feist,
Weidenweg 9, D-5060
Bergisch Gladbach 3,
West Germany
(72) Inventor
Artus Feist
(74) Agents
Keith W. Nash & Co.,
22, Hills Road, Cambridge
CB2 1JP

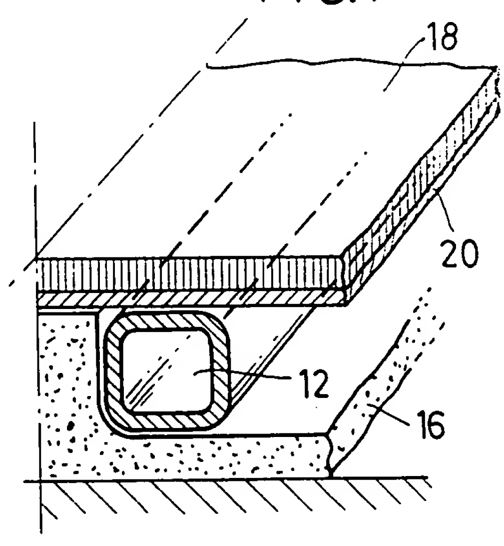
(54) Improvements in Building Heat Transfer Systems

(57) A pipe (12) of square cross section, which may be made of plastics or of metal, is embedded in the floor, walls or ceiling of a building.

The pipe (12) is located in a profiled plastic plate (16) and is covered with a metal plate (18) and an adhesive layer (20). The square cross-section of the pipe provides a large surface area through which heat may be transferred to or from the surrounding surface below which the pipe is mounted.

The pipe forms a heating or cooling element depending on the temperature of the fluid, which may be water, passing through it.

FIG.7



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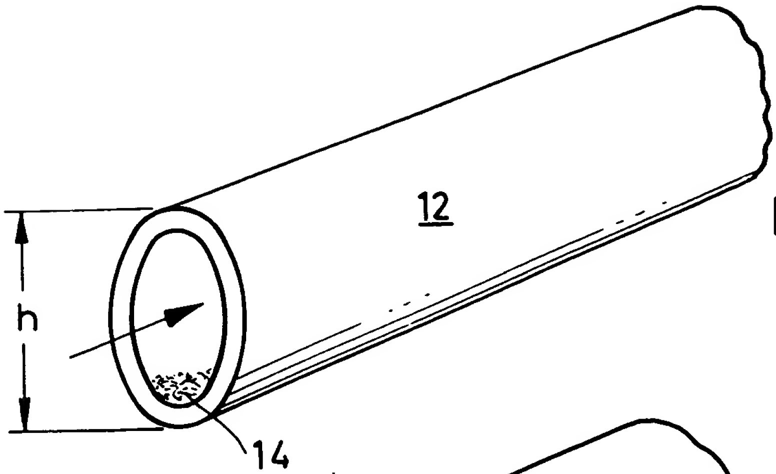


FIG. 1

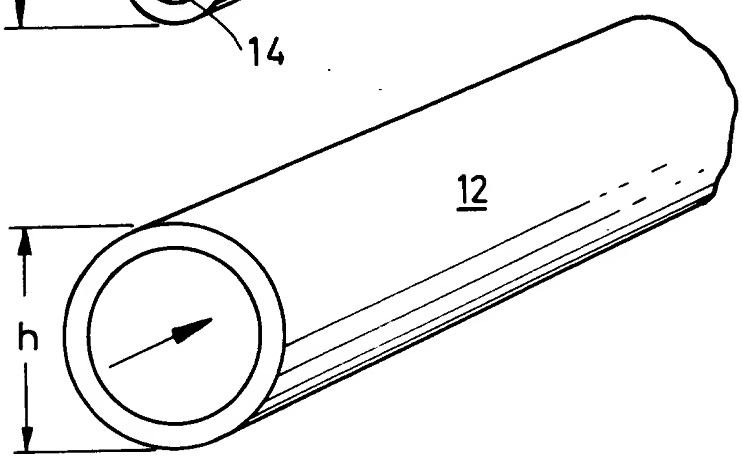


FIG. 2

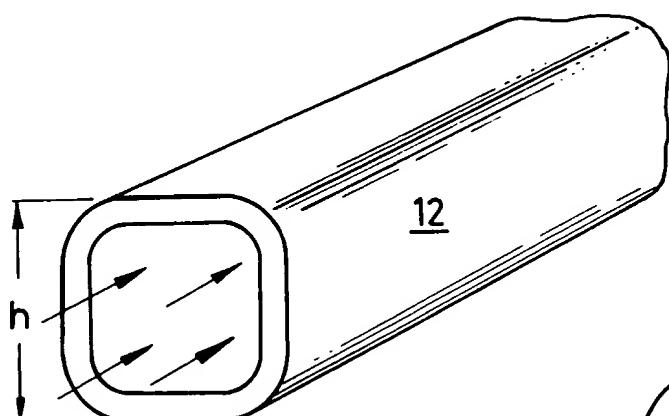


FIG. 3

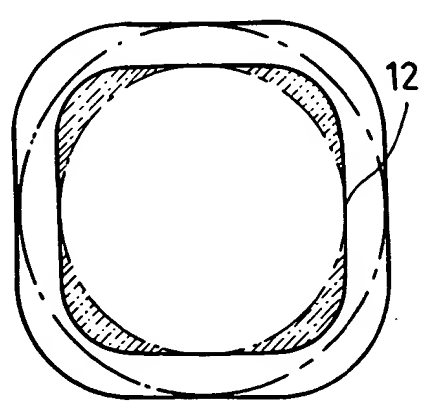


FIG. 4

FIG. 5

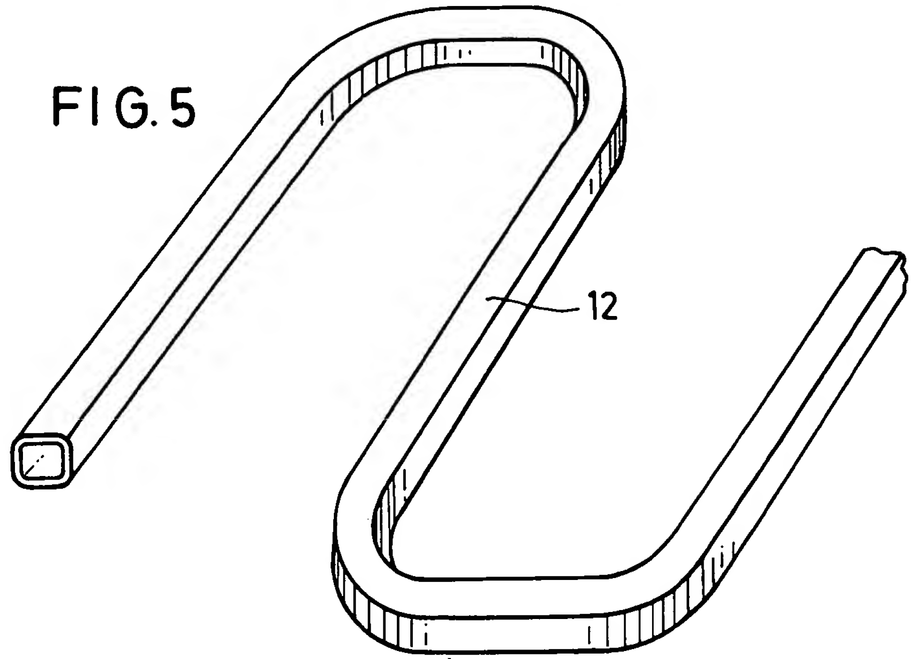


FIG. 6

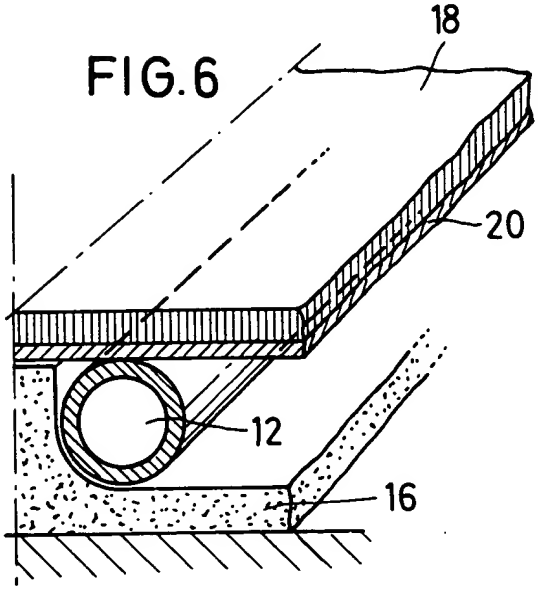
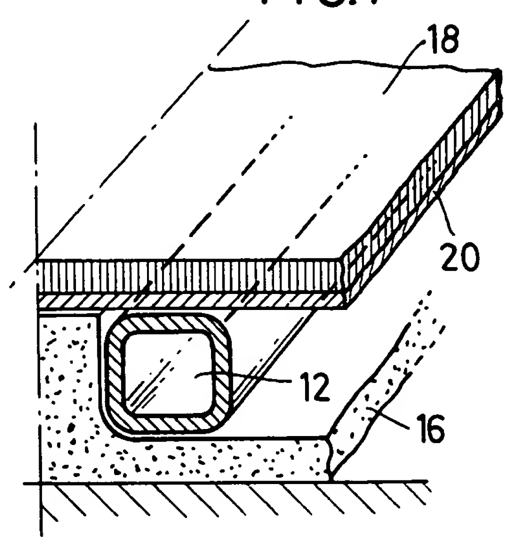


FIG. 7



SPECIFICATION

Improvements in or Relating to Building Heat Transfer Systems

Field of Invention

The invention relates to improvements in a building or surface heat transfer-system of the type having pipes conveying a fluid heat carrier such as a heating agent or coolant embedded in the floor, walls and/or ceiling of the building or in a surface. They must also be fixed in finished elements which are generally plastics mounting plates which have knob-like projections or similar holders for the pipes. German Patent Specification No. 2,720,361 shows an example of a mounting plate of this kind.

Background to the Invention and Prior Art

In order to provide a floor-heating system, pipes are laid on the floor in loops which extend back and forth in accordance with a predetermined pattern, and the floor is then filled with flooring plaster. Various cross sections are known, or have been proposed, for the pipes used for this purpose. The pipes most frequently used have a circular cross section. Pipes having a circular cross section can be manufactured in a simple manner. The other properties for pipes having a circular cross section, such as physical and thermal properties, are average to good. Pipes having an oval cross section are also known. The advantages of pipes having an oval cross section compared with those having a circular cross section is that they have a larger surface area with the same internal cross section or interior volume. This improves the transfer of heat from the heating agent flowing therethrough, such as hot water, to the surrounding floor or the flooring plaster. However, as will be further explained hereinafter, this increased transfer of heat has considerable attendant disadvantages. In order to obtain an even larger surface area and thus a further improvement in the heat transfer, a pipe has been proposed which is basically of circular cross section but whose surface is corrugated or grooved.

This short description of the prior art shows that successful attempts have been made to depart from pipes having a circular cross section and to develop pipes which have a larger surface area with the same internal cross section and which thus enable improved heat transfer. The larger surface area can be immediately calculated by simple mathematical formulae. The heat transfer is, in the first approximation, directly proportional to the surface area. The heat transfer can also be rapidly measured with simple devices. Thus, the heat transfer is a physical quantity which can be rapidly and simply determined by simple mathematical and measuring means. The advantage of improved heat transfer is immediately obvious. In the dimensioning of floor heating systems, improved heat transfer of the pipe cross sections used can, and is, immediately taken into account. It can result in the use of fewer lengths of pipe per unit of area of the floor and thus in a reduction in the density with which the pipes are laid. However, long-term observation of floor heating systems in which pipes having an oval cross section were used have shown that these pipes have numerous disadvantages. In particular, the improved heat transfer resulting from their relatively larger surface area only constitutes an apparent advantage. The improved heat transfer which has been assumed is cancelled by other circumstances and, moreover, only constitutes a short term effect.

In addition to the thermal properties of a pipe, including the heat transfer, other properties have to be taken into consideration such as the ease with which the pipes can be laid, the solidity or the stability of the flooring plaster surrounding the pipes, and particularly the constancy of the values calculated, such as heat transfer, internal cross section etc. during the entire lifetime of the floor heating system which covers a period of up to several decades.

It is known that central heating systems operating with conventional radiators clog after they have been in operation for many years or decades. The suspended substances in the water, including the so-called boiler scale, are precipitated during the course of years. The suspended substances are precipitated and cake to form so-called boiler scale or lime particularly at locations at which the heating water has a low rate of flow. The effective internal cross section is thus reduced and the flow resistance increases. A preliminary stage in the formation of boiler scale is clogging in which, even after a short period of operation, suspended substances are deposited at locations, at which the heating water only flows through the pipe at a low velocity. In pipes having an oval cross section, these locations are the two converging sides of the internal cross section. Pipes having an oval cross section are also frequently laid with their major axis vertical. Thus, a side converging in this manner, or a small internal cross section, is located at the bottom. Clogging is thus promoted by virtue of the fact that, when the system is inoperative, the suspend substances are deposited downwardly as a result of gravity and cake together. This means that the effective internal cross section of pipes which have an oval cross section, and which are laid with their major axes vertical, is reduced after a short period of operation. A short operating period of this kind is reached after a few heating periods. The thermal performances of the entire floor heating system decreases in conformity with the decreasing effective internal cross section of these pipes having an oval cross section. The presumed advantage, which exists during a first short operating period, of high thermal transfer is thereby not only eliminated but can even have disadvantageous consequences.

A further disadvantage of pipes having an oval cross section is that they have different moments of resistance along their major and minor axes.

This leads to difficulties when laying the pipes and renders them less convenient to lay. Force has to be applied when laying pipes in the prescribed form of loops etc., since they resist any change of shape as a result of considerable twisting which is non-uniform along the two axes of the pipes. The flooring plaster can also be adversely affected when pipes having an oval cross section are laid in the flooring plaster with their major axes vertical. The top and bottom tapering ends of the pipes act like wedges. The flooring plaster breaks up particularly when it is not very thick, and cracks appear.

For geometrical reasons, pipes having an oval cross section are weaker along their minor axes than along their major axes. Thus, they are inferior to pipes having a circular cross section. Thus, for the purpose of compensation, and in order to obtain adequate strength, pipes having an oval cross section are manufactured with a greater wall thickness. Thus, the greater heat transfer resulting from their larger surface area is again reduced. As a result of this greater wall thickness, they have far greater rigidity than pipes having a circular cross section and are thus difficult to lay. They cannot be laid along such sharp bends as pipes having a circular cross section. Thus, the parallel runs of the individual loops of pipe have to be located further apart, thus reducing the density with which the pipes are laid. The overall height is further increased when the pipes are laid with their major axes vertical. The volume of the flooring plaster surrounding them is increased. Thus, a larger amount of flooring plaster has to be heated, and the thermal efficiency of a floor-heating system is reduced.

Consequently, while the pipe having an oval cross section has, in accordance with the explanation given above, an initial advantage of a presumably slightly greater transfer of heat, but predominantly has disadvantages after operating for only a few heating periods, all the properties of pipes having a circular cross section exhibit substantially average values.

Objects of the Invention

It is an object of the invention to provide a pipe, to be used in the field of floor or surface heating, with a cross section such that the pipe exhibits only optimum values with respect to its surface area, that is to say, the heat transfer, with respect to its effective internal cross section, with respect to the ease with which it can be laid, and also with respect to the stability of the flooring plaster which receives it.

It is a further object of the invention to provide a pipe which constitutes a reliable product which maintains high initial values unchanged during the entire period of operation of a floor or surface — heating system.

The Invention

Unexpectedly, in accordance with the invention, this object is achieved by imparting a square cross section to the pipe.

Compared with its internal cross section, a pipe having a square cross section has, when considered from the mathematical/geometrical viewpoint, a smaller surface area than a pipe having an oval cross section. Not only does this internal cross section remain fully open during the entire lifetime of a floor-heating system which includes the pipe, but the pipe having a square cross section has other properties which lead to improved heat transfer. Thus resides, on the one hand, in greater radiation. This results from the fact that the entire topside of the pipe, that is to say, approximately 25% of its total surface area, is directed upwardly and the heat is radiated directly upwardly. Heat transfer is further improved by virtue of the fact that, when placing sheet-metal plates onto the pipes, the sheet-metal plates can be glued directly to the sheet-metal plates from approximately 25% of the total surface area of the pipe. Direct heat transfer of this kind cannot be effected with any other known cross section. Furthermore, the two perpendicular side walls of the pipe ensure intensive lateral radiation. This allows the pipes to be laid at greater distances apart.

The free internal cross section of a pipe having a square cross section is maintained during the entire lifetime of the pipe. This resides in the fact that the flow is not obstructed by a constriction at any location of the cross section, so that the depositing of sediment is not promoted. Furthermore, turbulence is formed by the straight surfaces, and particles of solid material are thus either flushed away or at least are kept in suspension. The latter leads to a greater specific gravity of the heating water and thus to improved transfer of heat.

It is also very convenient to lay a pipe having a square cross section. Its moment of resistance is equal along its two axes. Thus, it does not tend to assume an undulating shape during laying. This would result in varying distances between adjacent runs of pipe which would in turn lead to areas of differing heat output. Pipes having a square cross section can also be laid in bends in a simple manner. There is no twist.

A pipe having a square cross section also leads to greater stability of a flooring plaster. It has no surfaces or shapes which act like wedges and which could split or notch the flooring plaster. Thus, the statics of a floor-heating system containing pipes of this kind can therefore be considered to be very satisfactory.

Considered overall, a pipe having a square cross section combines a large surface area and a large internal cross section. Thus, it has small spatial requirements relative to its thermal efficiency. Thus, there is no dead space, and the transfer losses are kept small.

In an advantageous embodiment, the corners on the internal and external walls of the pipe are rounded. The rounding on the internal wall avoids locations at which solids could be deposited as a result of a small flow. The rounding on the external wall avoids a notching effect on the

surrounding flooring plaster. An amount of approximately 25% of the inside width of the internal cross section has proved to be advantageous for the radius of curvature of the roundings of the corners of the inner wall.

The pipes in accordance with the invention may be made from a flexible or rigid plastics material or, alternatively, from metal.

The pipe in accordance with the invention has been described above and will also be described in the following description of the drawings, in connection with a floor-heating system. However, its advantageous properties are also valid when the pipe is used for other purposes of transferring heat or cold. By way of example, it can also be laid in wall and ceiling heating systems and in any surfaces. A coolant can flow through the pipe instead of heating water, the pipe then forming part of an air conditioning system.

Pipes in accordance with the prior art, the pipe in accordance with the invention, and examples of laying the pipe, will be explained with reference to embodiments illustrated in the drawings.

In the Drawings

Fig. 1 is a perspective, fragmentary view of a pipe having an oval cross section in accordance with the prior art,

Fig. 2 is a perspective, fragmentary view of a pipe having a circular cross section in accordance with the prior art,

Fig. 3 is a perspective, fragmentary view of a pipe having a square cross section,

Fig. 4 is a cross section through the pipe in accordance with the invention, shown together with the cross section of a pipe having a circular cross section,

Fig. 5 is a perspective illustration of a pipe, in accordance with the invention, having a square section and arbitrarily laid in an S-shape,

Fig. 6 is a perspective, fragmentary view of a pipe which has a circular cross section and which is fitted in a floor-heating system having sheet-metal plates, and

Fig. 7 is a corresponding illustration of a pipe, in accordance with the invention, having a square cross section.

Description of Embodiments

A pipe 12 having an oval cross section is illustrated diagrammatically in Fig. 1. Its major axis extends vertically. This corresponds to fitting in an upright position. This results in an installation height *h*. This corresponds to the length of the major axis. The arrow indicates the heating water flowing therethrough. After a relatively short period in operation, sediment is deposited on the bottom of the tube 12 or at its tapering bottom end which has a correspondingly converging cross section. The sediment 14 is illustrated diagrammatically. Fig. 2 is a diagrammatic, perspective view of a pipe 12 of conventional construction having a circular cross section. A pipe 12 having a square cross section in accordance with the invention is shown in Fig. 3. This pipe 12 also has an installation height *h*. The four arrows are intended to show that the heating water can find a large free internal cross section and can flow through the pipe more rapidly with a correspondingly smaller flow resistance.

For the following comparative illustration, it will be assumed that the installation height *h* is ten units of length. In practice, the installation height *h* or the diameter of the pipe 12 of circular cross section will be, for example, 18 mm. When $h=10$, the pipe 12 of circular cross section has a circumference of 31.4 and, ignoring the wall thickness, a free internal cross section of 78.5. Ignoring the wall thickness and the rounding of the corners, the pipe, in accordance with the invention, having a square cross section has a circumference of 40 units of length and a free internal cross section of 100 units of area. These numerical values are in excess of those of the pipe 12 having a circular cross section. It is to be noted that the larger comsumption of material which the pipe having a square cross section requires, as well as the larger volume which it takes up in the flooring plaster, are available or are even advantageous. Thus, this numerical example also shows the superiority of the pipe having the square cross section in accordance with the invention. Even better numerical values ensue when comparing this pipe with the pipe 12, shown in Fig. 1, having an oval cross section.

A pipe having a circular cross section and a pipe having a square cross section are illustrated one within the other in Fig. 4, drawn to a larger scale. The four hatched regions constitute the area by which the internal cross section of the pipe having a square cross section is greater than that of the pipe having a circular cross section.

A pipe 12 having a square cross section, and laid in the form of an S, is illustrated in perspective in Fig. 5. The illustrated shape has three portions of pipe which are parallel to one another, and two bends. This S-shape was deliberately chosen to show that the pipe having the square cross section in accordance with the invention can be laid in any shape without resistance and will retain the said shape. This applies both to portions of the pipe which extend parallel to one another and to bends etc. The pipe does not exhibit a twist or a different moment of resistance along its two axes.

Figures 6 and 7 are comparative illustrations of a pipe 12 having a circular cross section and a pipe having a square cross section in accordance with the invention. The two pipes 12 are located in profiled plastics plates 16 and are covered with sheet-metal plates 18. These plastics plates 16 are the finished elements or mounting plates mentioned initially. The pipes 12 are located directly on the plastics plates 16 and the pipes 12 withan adhesive 20 interposed therebetween. Theoretically, only linear contact exists between the pipe 12 and adhesive 20 in the case of the pipe 12, shown in Fig. 6, having a circular cross section. In practice, contact takes place along a

narrow strip. However, in Fig. 7, the pipe 12 and the adhesive 20 are in contact with one another across the entire topside of the pipe. Thus, the heat can flow into the adhesive 20 or the sheet-metal plate 18 directly by way of a large surface area. This applies particularly when the adhesive 20 contains additives which increase its thermal conductivity. Thus, the figures show that, when laid in the manner shown, the pipe having a square cross section in accordance with the invention ensures far better transfer of heat. This would apply to an even greater extent when comparing a pipe of square cross section with a pipe of oval cross section which is laid with a vertical major axis.

Claims

1. The improvement in a building heat transfer system of the type having pipes conveying a fluid heat carrier embedded in the floor, walls, and/or ceiling of the building or in any surface characterized in that the pipes are of square cross section.

2. The improvement of claim 1 further characterized in that the inner and outer walls of the pipes are rounded at the corners thereof.

3. The improvement of claim 2 further characterized in that the radius of curvature of the inner walls of the pipes at the corners thereof is approximately equal to 25% of the internal width of said pipes.

4. The improvement of claim 1, 2 or 3 further characterized in that the pipes are made of a plastic material.

5. The improvement of claim 1, 2 or 3 further characterized in that the pipes are made of metal.

6. A building heat transfer system substantially as herein described with reference to, and as shown in, Figs. 3 to 5 and 7 of the accompanying drawings.

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